Aggregate Airspace Congestion Modeling

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joint work with Michael Ball, Yufeng Tu, and Bala Chandran

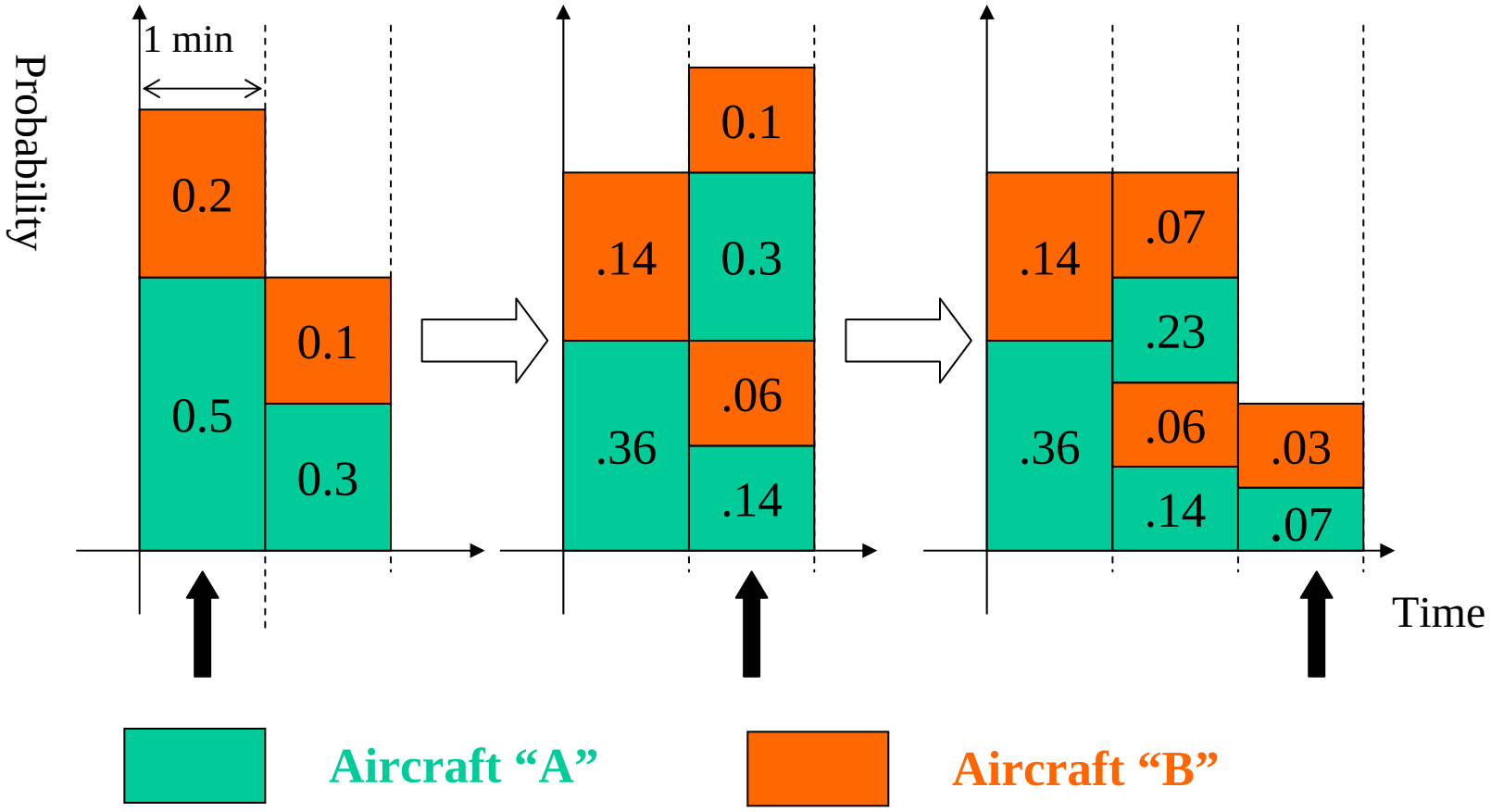
Evolving from Monitor Alert

- Improvements
  - Queueing effects in the NAS caused by capacity restrictions
  - Stochastic departure times of aircraft
- Applications
  - Collaborative decision-making and schedule refinement
  - Congestion alerts over the course of the day
- Outputs
  - Probability of congestion in sector *x* at time *t*
  - Distribution of delays to flights
  - Airspace capacity estimation

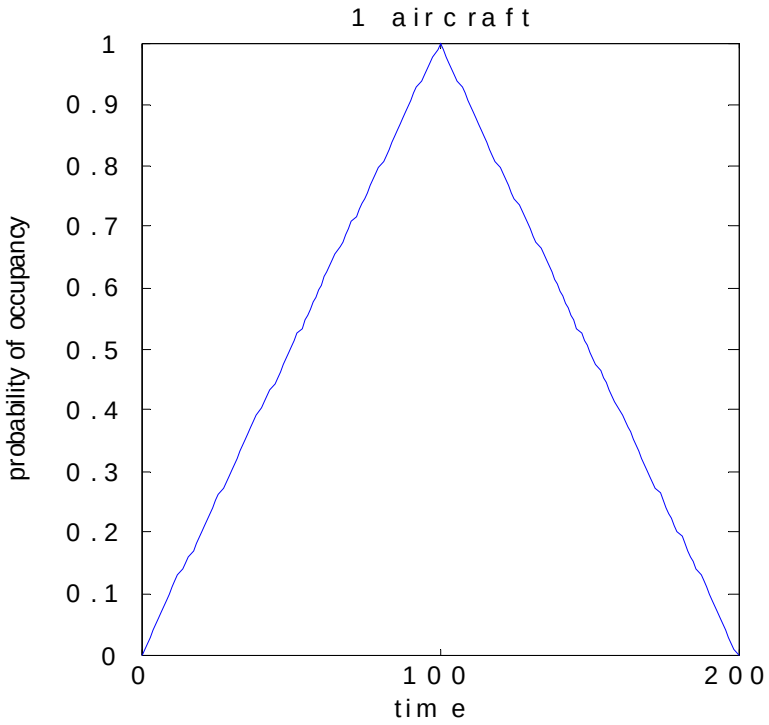
Issues related to model scale

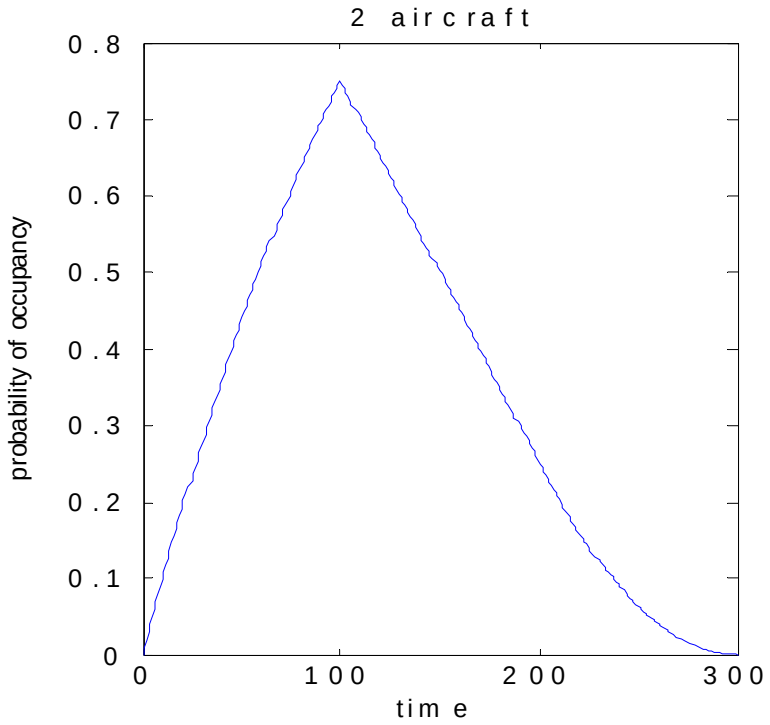
- Microscopic simulation models are OK when time is plentiful
- Our goal: rougher estimates in a single pass
- Limited network topology
- Fluid modeling of “probability flows” – continuum diffusion equations operating on tandem queues
- Convergence, or “laws of large numbers”

Propagation of “probability packets”



Example of interaction effects





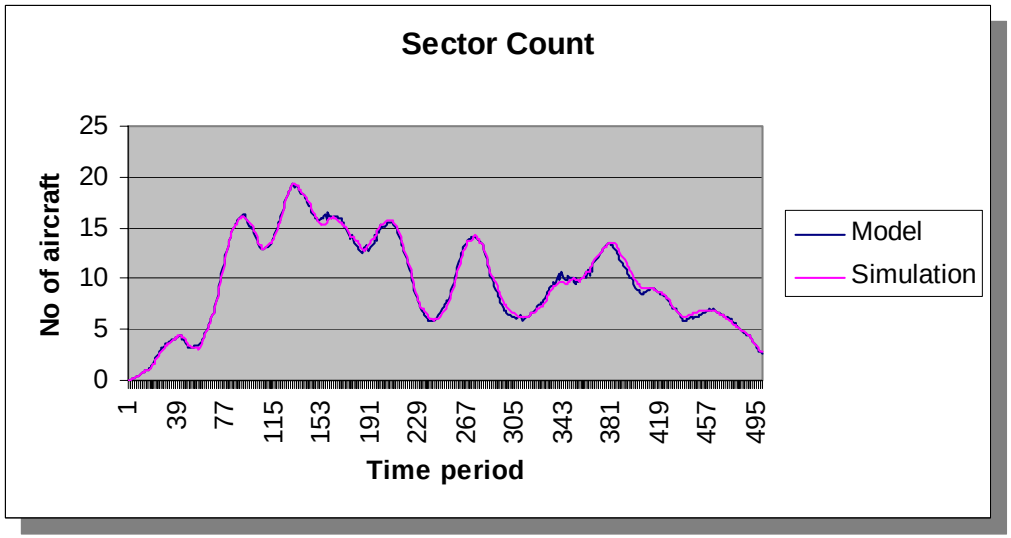
- P{cancel} = 0
- t_A ~ uniform(0,100)

For aircraft A and B:

- P{cancel} = 0.5
- t_A, t_B ~ indep. uniform (0,100)
- server capacity = 1

Preliminary results

- Bala attempted to categorize interactions according to some degree of severity: “strong” and “weak” and developed heuristic methods to handle these situations:



Flight No	Predicted Travel Time	Actual Travel Time
119	119.555	116.199
340	111.755	114.744
954	356.743	364.500